

THE IMPORTANCE TO THE SURGEON OF  
FAMILIARITY WITH THE BACILLUS  
COLI COMMUNIS.<sup>1</sup>

By ROSWELL PARK, M.D.,

OF BUFFALO.

PROFESSOR OF SURGERY IN THE UNIVERSITY OF BUFFALO.

THE bacterium coli commune was first described, in 1885, by Escherich,<sup>2</sup> and was at first regarded as a saprophyte and intestinal parasite. In 1887 Hueppe found it in the stools of patients suffering from cholera. Its positive pathogenic properties were first made known by Laruelle in 1889,<sup>3</sup> then by Tavel,<sup>4</sup> also by Roux and Rodet,<sup>5</sup> who fully established its pyogenic properties.

It would appear unnecessary here to go into its morphology. Suffice it to say that it is a short, rod-shaped organism, its shape causing it to be generally known as the *bacillus coli communis*, which in the hanging drop is motile, its motility consisting in a sort of oscillation, sometimes with a rapid translation. Its possession of flagella is disputed; at most, it does not have more than three of them, while the typhoid bacillus possesses from eight to twelve. It attacks peptone slowly, and glucose and lactose much more readily. It seems to enjoy a sort of commensalism with other organisms, possibly even a symbiosis. In

<sup>1</sup> Read before the American Surgical Association, at Buffalo, June 1, 1893.

The writer desires to acknowledge his indebtedness to the monograph of Dr. Maxime Macaigne, "Le Bacterium Coli Commune" (Paris, 1892), to which he would refer those interested in the subject.

<sup>2</sup> Fortschritte d. Med., 1885.

<sup>3</sup> Péritonite par Perforation, La-Cellule, 1889.

<sup>4</sup> Thyroidite, Correspondenzblatt f. Schweizer Aerzte, 1889.

<sup>5</sup> Lyons Médical, 1889.

the healthy intestinal canal it practically never exists alone, but it is found alone in other parts of the body under certain conditions, with some of which this paper has to deal. Its discoverer, Escherich, was able to determine a most significant feature in the life history of its organism, *i.e.*, that it varies in virulence within very wide limits, while he and others have shown that in what we may call its normal or ordinary state it is not usually virulent. This will account for the slightly infectious property of the pus met with in certain intra-abdominal abscesses. Under certain conditions, as during some but not all diarrhœas, but especially those of the summer season, it gains in strength or virulence to a marked, and frequently to a fatal, degree.

To it has been ascribed by various observers the property of rapid migration after death. For instance, Letienne has found it in the bile, where it is not supposed to be normal, within forty-five minutes after death; it also invades other organs soon after, if not before, death, since Welch found it in various organs in thirty-three out of 200 autopsies.<sup>1</sup> This apparently rapid migration is probably fallacious, it being more likely that it escapes from its normal habitat, the intestinal canal, before death.

That it varies in virulence within wide limits is most certain, its variation commonly finding its highest expression in cases of cholera nostras, since when recovered from these cases and inoculated it usually causes death from acute septic infection within twenty-four hours. This virulence it can retain in cultures for several months, although those on agar lose it much more speedily than those in bouillon. Cultures may thus be intentionally attenuated until virulence is completely lost. Welch has noted death in small animals in six weeks after inoculation, from an apparently non-septic cachexia, with atrophy of the spleen.<sup>2</sup> When it manifests pyogenic properties and causes pus it appears to be because it has become, in a measure, attenuated. When

<sup>1</sup> Medical News, December 12, 1893.

<sup>2</sup> Blachstein, working in Welch's laboratory, showed that injection of 1 c. c., or even less, of bouillon culture of colon bacillus in the ear veins of rabbits may cause the death of the animals as long as six weeks after the inoculation. These animals were much wasted, and presented peculiar appearances in the liver and bile. The latter contained the colon bacillus in large numbers.

death occurs, however, and seems due to suppuration produced by it, although probably due to an intoxication, the bacilli are rarely found anywhere else save in the pus. Apparently, then, we have to deal with the organism under two conditions: at one time as an exceedingly active agent, producing acute septic infection, and again as a common pyogenic organism, producing local abscess. Quite recently Gilbert and Lion<sup>1</sup> have published the results of certain investigations into the action upon the gray matter in the cord of ptomaines or toxines produced by this organism. According to these observers this toxic agent appears to be capable of setting up an acute infectious central myelitis. If this be true, we have an explanation for certain paralyzes which occasionally followed acute enteritis and urinary infection.

*Identity with Organisms Otherwise Known.*—There is good reason for believing the bacillus coli communis to be identical with organisms discovered by others and given various other names. Thus Weisser appears to find complete identity between this organism, the bacillus Neapolitanus of Emmerich and Brieger's fæces bacillus. In 1885 Passet described a bacterium from a perirectal abscess, which he called bacillus pyogenes foetidus. While Passet's bacillus has usually been found in abscesses occurring in the neighborhood of the lower bowel, I have myself, for instance, found it in an abscess of the brain. Although there is complete morphological identity between this one and the colon bacillus, the former renders bouillon with glucose acid, but without gas production. In other media there are also very trifling differences. Nevertheless, there is great reason to think that these trifles and discrepancies may be fairly regarded as due to variations into which the question of polymorphism also enters. Tentatively, at least, we may regard them as identical.

Recently Clado and Albarran<sup>2</sup> have described a urinary pyogenic bacterium which Morelle and Krogus have considered identical with the bacillus lactis aerogenes. And now Achard

<sup>1</sup> Société de Biologie, Feb. 13, 1892.

<sup>2</sup> Compt. rend. Soc. de Biol., 1891, p. 830.

and Renault regard both of these as identical with the colon bacillus.<sup>1</sup>

Should these identifications prove correct, they would serve to show how generally wide-spread this organism is, and of how much more importance in a pathological sense than was at first supposed, while if incorrect they need in no wise detract from it. (The colon bacillus, moreover, presents striking analogies with the bacillus dysentericus of Chantemesse and Widal, the bacillus endocarditis of Gilbert and Lion, the bacillus enteritis of Gärtner). Of greatest importance, however, is it to emphasize that the colon bacillus is positively distinct from that of typhoid as described by Eberth. It has ordinarily the property of producing, if any pathogenic effect, an acute desquamative enteritis, forming at the same time certain toxic agents upon which the catharsis characteristic of this condition probably depends. But almost throughout the foreign literature on the subject I have found what seems to me too great a tendency to regard the extra-intestinal presence of the bacillus as a sort of cadaveric or post-mortem invasion. I have myself found it too often in pus from living patients, who have rapidly recovered after its evacuation, to permit me to take this view of it.

*Pathogenic Action.*—The following paragraph I quote from a paper by Welch, of Baltimore,<sup>2</sup> as being most illustrative and succinct: "Tavel's observations of the colon bacillus in connection with wound infection were followed by a few isolated observations of this organism either in the unchanged organs of the body or in suppurations, until recently A. Fränkel reports its presence in nine out of thirty-one cases of peritonitis. I first came across this bacillus in the organs of the body in 1890 in a case of multiple fat necrosis with pancreatitis, which I reported to the Association of American Physicians. As in this case diphtheritic colitis existed, it seemed probable that the lesions in the intestine opened the way for the entrance into the circulation

<sup>1</sup> The question of identity of the typhoid and the colon bacilli is considered at some length in an article by Trambusti in the *Centralblatt f. Allgem. Path.*, 1892. No. 8, May 1.

<sup>2</sup> Transactions of the Congress of American Physicians and Surgeons, Vol. 11, p. 5.

of this inhabitant of the healthy intestinal canal. This view subsequent experience has confirmed, etc.

"I have almost uniformly failed to find it outside of the intestinal wound when no demonstrable lesion of the mucous membrane existed. I am, therefore, prepared to say that this bacillus is an extremely frequent invader in intestinal disease. Moreover, the colon bacillus does not invade the blood and organs in the process of post-mortem decomposition.

"The cases in which we have found the colon bacillus under circumstances pointing to its pathogenic action have been as follows: Perforative peritonitis, four cases; peritonitis secondary to intestinal diseases without perforation, two cases; circumscribed abscess, three cases; and laparotomy wounds, six cases.

"Its presence several times in pure culture, in laparotomy wounds treated aseptically, although apparently not a source of serious trouble, was not a matter of indifference. It was generally accompanied with moderate fever, and a thin, brownish, slightly purulent discharge, of somewhat offensive, but not putrefactive, odor. The smooth and rapid healing of the wound was interfered with. In some of the cases there was evidence of intestinal disorder; in others this was not apparent, and infection from without could not be excluded.

"For the purpose of the present discussion, perhaps the chief interest of our observations concerning the colon bacillus is that they furnish an illustration of the possible predisposition to infection afforded by intestinal lesions, and also give an example of the much disputed auto-infection."

The above remarks of Prof. Welch were part of an address before the second Congress of American Physicians and Surgeons, in a discussion in which I was co-referee. If I may be permitted to quote from myself, I would like to repeat the following sentences from a paper which I read on that occasion:<sup>1</sup> "One form of entero-sepsis upon which but little has been written, and yet which furnishes a clue to many fatal cases,

<sup>1</sup> Transactions, p. 37.

especially those connected with abdominal surgery, is that produced by the bacillus coli communis. This is well known as a regular inhabitant of the alimentary canal, and its presence there is presumably connected with the chemistry of digestion. Yet, under certain circumstances, it either escapes or is carried beyond its normal limits, and, entering the portal circulation, perhaps the lymphatics also, appears to set up septic disturbances which are typified by the production of septic peritonitis, and possibly other forms of septicæmia in which the peritonæum does not primarily figure. The subject is an inviting one for further research. The condition has hardly yet been dignified by a proper name, though Drs. Welch and Councilman, who should be credited with its discovery, term it *colon infection*." These remarks were made in September, 1891, and the principal purpose of the present paper is to elaborate the ideas therein conveyed.

Welch's first observations on the colon bacillus were in April, 1891. He says, that "we have now found them in one or more organs of the body in thirty-three autopsies out of about 300. The suspicion at first entertained has been abundantly confirmed, namely, that lesions of the mucous membrane of the intestine open a way for the invasion of the colon bacillus into the blood and lymphatic vessels, and thence into the various organs and parts of the body. They were found with especial frequency in the lungs and kidneys, in the liver, mesentery, glands and spleen." It is not necessary that ulcerations or other perceptible lesions of the intestinal mucosa should exist, but it is certain that such invasion is a frequent result of the lesion. Colon bacilli were demonstrated by Welch in various organs, and this was true, especially in cases of amœbic dysentery. Certain cases, therefore, in which the bacillus seems to be a harmless invader should make one cautious in attributing pathogenic powers to it, unless it can be shown that other causes can be excluded. Welch concludes, however, that the colon bacillus may be the cause of lobular pneumonia, since he has found it in pure cultures in several such cases. In two cases of gall bladder lesion the bacillus was very abundant in the bile, which contained no other organism.

*Infection of the Biliary Passages.*—So far as the liver and biliary passages are concerned, the path of infection from the colon up to the common duct is widely open, and the wonder is that infection from this source does not happen much oftener. A further discussion of this subject might easily carry us into the consideration of lithiasis and disorders of biliary function, due to a mild infection from this source; indeed, this has already been discussed in the German Congress of Physicians, in Wiesbaden, in 1891; but to discuss it here would take us too far from our prime object.

Biliary colon infection may be primary or secondary, due in a measure to mechanical obstruction, or to direct passage of the organism, and may be accompanied by mild or severe manifestations of icterus, or by the lesions and symptoms of angio-cholitis. Indeed, the infectious form of icterus is nearly always due to colon infection, which, however, presumes nothing special in its symptomatology. The second form of icterus, due especially to biliary calculi, is by no means rare. Angio-cholitis naturally plays the principal rôle here, with or without multiple abscess of the liver. Several illustrative cases of each kind are reported by Macaigne.

Naunyn has called attention to the possible relationship between the formation of gall stone and the growth of this bacillus in the biliary passages. Several of the French writers consider suppurative inflammation of the biliary tract mainly due to the penetration of the colon bacillus. This makes no demands on the imagination, of course, since anatomically the path is widely open for them.

Bignami<sup>1</sup> found pure culture of the colon bacillus in one case of suppurative angio-cholitis with disseminated abscesses of the liver. On injecting cultures of the same into the biliary passages of guinea-pigs he succeeded in provoking identical disturbances.

In brief, beside a rapid infection of the biliary system, with total degeneration of the parenchyma, and manifestations of acute jaundice, the colon bacillus gives rise to a more slow

<sup>1</sup> *Bullet. della R. Accd. med. di Roma*, 1891, F. IV & V.

alteration of biliary passages characterized by catarrhal and suppurative angio-cholitis, with production of necrotic foci and hepatic abscesses, all of which may run a peculiar clinical course without fever, or at least with less pyrexia than is found when the same trouble is caused in an ordinary pyogenic cocci.

*Peritonitis.*—It was in 1885 that Cornil laid stress on the rôle played by intestinal bacteria in the production of perforative peritonitis; at that time, however, no final distinctions had been made. Such cases as those herein alluded to, together with many others summarized in the monograph of Macaigne, must make this matter now very plain. We must not forget in this connection the researches of Wagner, Gravitz and others, who have shown how often the introduction into the peritonæum of various bacteria is inoffensive, providing only, and this is the important item, that the liquid in which they are planted be non-irritating, and in quantity not exceeding the capacity of the peritonæum for absorption. It will be seen at once, however, how this condition is violated in cases of intestinal perforation. It has also been established beyond doubt that the colon bacillus found in the pus of a case of suppurative peritonitis, of intestinal origin, is capable of reproducing the same condition in animals, and must, therefore, doubtless be the active factor. In substantiation of these statements Macaigne adduces eighteen cases, and others have been put on record by other observers. It would appear, then, that we may have a colon infection in the peritonæum from intestinal lesions which do not go to the point of perforation.

Chantemesse, Widal and Legry have reported the following cases of pseudo-puerperal infection by the colon bacillus:

A woman four months pregnant was seized with acute obstruction, due to uterine retroversion. She soon appeared like a cholera patient without the diarrhœa. The retroversion was reduced, the rectum emptied, and she improved. Two days later, and eight days after the first trouble, she miscarried. The uterus was curetted, and cultures from the placental debris showed colon bacillus and no other organism. Four days later she died, and on the autopsy the peritonæum was found to contain greenish sero-pus, with gangrene of an



intestinal loop. In the fluids examined, including the blood from the heart, there were only colon bacilli.

Lesage reports the following case of sub-acute enteritis, abortion and fatal peritonitis produced by the colon bacillus:<sup>1</sup>

A young woman, ailing from diarrhoea and anorexia for four days, aborted at the fourth month, then had diarrhoea and fell into a typhoid condition. Six days later her uterus was curetted, and then the condition was regarded as febrile sub-acute enteritis. On examining the stools virulent colon bacilli were found. At the end of the third week the abdomen was distended and pyosalpinx was diagnosed; she died on the thirty-fifth day of her illness. Autopsy showed adhesive and localized peritonitis with foci of pus and pyosalpinx. Cultures from this pus gave colon bacilli and nothing else.

Varvachi<sup>2</sup> reports six cases of perforative peritonitis during the course of typhoid, in which he examined the peritoneal exudate, in all of which he found the colon bacillus, in three cases mixed with other forms; it was also found in the heart blood.

Malvoz<sup>3</sup> also reports six cases of peritonitis, mostly of the non-perforative variety, secondary to acute intestinal lesions, in all of which the colon bacillus seemed to be the active infectious agent; it being also found in the heart blood.

It is in cases of perforative peritonitis that the colon bacillus is most often found (though not always in the exudate) and sometimes alone. In three cases of peritonitis due to intestinal ulceration, without perforation, Welch found these bacilli in large number and uncontaminated. The exudate was sero-fibrinous, and not distinctly purulent. In one case of ruptured tubal pregnancy the fluid withdrawn with the sterilized aspirator needle from the peritoneal cavity, before it was opened, yielded a pure culture of this organism. Welch has also found it in peri-appendical abscess, but he emphasizes, as do others, and as would I, that it is a mistake to say, as Malvoz has recently said,

<sup>1</sup> Macaigne, p. 67.

<sup>2</sup> Lo Sperimentali, Aug. 15, 1891.

<sup>3</sup> Archives de Med. Experimentale, No. 5, 1891.

that all cases of peritonitis due to intestinal lesions are referable to the colon bacillus. Welch also found it pure in a case of tumor adherent to an ulcerated cancer of the rectum.

He also emphasizes the importance of remembering that typhoid ulceration opens the way for invasion of the colon bacillus, and that on account of the morphological resemblance of the two organisms a mistake in statements might easily be made.

At a meeting of the Société de Biologie, Paris, January 24, 1891, Marfan and Lion reported two cases of elderly individuals dying of collapse after acute enteritis. There was found infection of the mesenteric glands and the pericardial fluid, as well as the heart blood. The cases had run a course absolutely without fever, and died of collapse without their severity being realized. Later, at the session of December 12, 1891, Achard and Renault reported finding the colon bacillus in a case of nephritis. Reblaud voiced his views with regard to the pathogenesis of cystitis in women, he having found in a number of cases the bacillus pyogenes, which we now suppose to be identical with the colon bacillus.

At the meeting of January 30, 1892, of the same society, Clado, in a lengthy communication upon the anatomy of the vermiform appendix, stated that in three cases of appendicitis with abscess he had found the colon bacillus in pure culture. At this meeting and the next one the subject of its pyogenic properties was discussed. Lesage took ground that the organism produces pus, as in the gall bladder, the peritonæum and the territory around the cæcum, and that it does not produce general infection, at least as a rule; but it was possible to have a more and a less virulent form of the organism in the same case. This is illustrated in a case of abscess of the lung after infectious enteritis. Gilbert and Lion spoke particularly of the paralyses which may follow colon infection, and particularly of that of the intestinal and genito-urinary tract; they having often seen paraplegia after inoculation of guinea-pigs. At the session of March 5, Girode reported the case of a man suffering from dyspepsia, biliary vomiting, progressive icterus and albuminuria.

The pyloric region was the seat of an indistinctly circumscribed tumor. He died of collapse, and on autopsy there was found a large stone in the gall bladder, around which had formed an inflammatory mass, which involved the colon, duodenum, much of the pancreas and the gall bladder. The pancreatic and biliary passages contained pus, and there were numerous localized peritoneal collections. In all of these the colon bacillus and no other organism was found.

*Strangulated Hernia.*—In 1861, Verneuil expressed the thought that the liquid found in hernial sacs after strangulation would be found to contain toxic and irritating matter. In 1867 Nepveu, working for him, discovered cocci in such fluid. Since then Verneuil has repeatedly called attention to this subject. He explained the presence there of bacteria by their migration through the intestinal walls, which is often favored by injudicious taxis; from the sac they may pass into the general circulation or into the peritoneal cavity. In 1889, Clado<sup>1</sup> described numerous cases of choleric form strangulation in which he met with a bacterium in the fluid from the sac, especially under the three following conditions: (1) Dilatation and increase of intra-intestinal tension; (2) visceral congestion and ulcerations of the mucosa; (3) effusion into the peritoneal cavity, which might be invaded independently of the sac. From the sac the bacteria of hernial invasion spread and produce evidence of auto-intoxication, or before doing this they may localize themselves in some viscus and provoke the lesions described by Ledoux and Verneuil. Clado isolated from its source and studied the bacterium, which he found pathogenic after inoculation, and which in animals produced septicæmia, and which, moreover, has been found in all the viscera of patients dying of strangulated hernia. Now since the colon bacillus is fully known, it is recognized as identical with Clado's bacterium.

Garré<sup>2</sup> examined a number of cases of strangulation, and not finding microbes in all of the cases naturally concluded that they were not always present, and that the advice given by

<sup>1</sup> Congrès de Chirurgie.

<sup>2</sup> Fortschrt. d. Med., 1886.

Verneuil to always disinfect the strangulated loop and the sac is not so excessively urgent after all.

Bonnecken<sup>1</sup> found micro-organisms, for the most part the colon bacillus, in every instance of numerous experiments in producing artificial strangulation in dogs. He admits that in these cases death is largely due to septicæmia. When reduction is not accomplished the amount of the exudate is augmented beyond the power of the peritonæum to dispose of it. If the victim resists long enough he may have gangrene of the intestine and perforation in consequence.

Fränkel also sought the cause of death in rapidly fatal cases, and decided that the operation could not be blamed, since by itself it is too insignificant; nor could it be considered shock. It must, therefore, be of the nature of an infection and intoxication.

*Other Infections.*—Bourges claims that the colon bacillus is often found in the *tonsil* in scarlatinal angina; in seven such cases he three times found it associated with other microbes; in seventeen cases of pseudo-membranous angina due to scarlatina he found it four times, always with others. In every one of these cases it was cultivated and inoculated and found quite virulent. Other experiments have shown that in such cases it has a powerful virulence, but is capable of rapid attenuation.

Even in the *stomach* this organism is capable, now and then, of producing a local disturbance with necrosis of the mucous tissue, and consequent ulceration. Possibly by this same mechanism it may produce those ulcerations in the intestine after dysentery, which, according to Kelch and Kiener, are characterized by the appearance, as it were, of an eschar, the parts looking as if a strong caustic had been applied over a limited area.

Recalling the identity of the colon bacillus with Passet's bacillus *foetidus*, we see how it may be found outside of the lower end of the intestinal canal, as in the perirectal abscesses which are so common.

Mascattello<sup>2</sup> reports an acute abscess of the ischio-rectal

<sup>1</sup> Virchow's Archiv., 1891, B. 120.

<sup>2</sup> La Riforma Medica, 1891, No. 163.

fossa resulting from an ulcerative proctitis; it contained thick, offensive pus, in which only the colon bacillus could be found, and which, when cultivated and injected subcutaneously into guinea-pigs, produced acute abscess with the same offensive properties.

Although it does not concern the surgeon so much, it is very interesting to know that *endocarditis* may be caused by the colon bacillus, which provokes vegetation upon the valves in practically the same way as do those micrococci which commonly produce this disease in its acute infectious form. This has been proved in cases reported by Netter and Martha,<sup>1</sup> and by Lion and Menetrier.<sup>2</sup> This particular point has for me a very great interest, since I once lost a patient after operating for gunshot perforation of the intestine, who died of acute peri- and endocarditis, the autopsy showing no yielding of the intestinal sutures, and the local condition being perfectly satisfactory. For so sudden an endocardial lesion I could not account at the time. This occurred some years ago, in a case operated on in an emergency while I was in Bradford, Pa., upon quite different business. It occurs to me now that an explanation may be found in the facts above recited.

That the colon bacillus may give rise to an acute infectious *strumitis* has been shown by a case reported by Tavel.<sup>3</sup> This case is now almost classic, and concerns the removal of goitre with closure of wound, subsequent swelling and production of pus, in which were found only colon bacilli.

Macaigne states that there are at least six cases of acute meningitis on record in which the colon bacillus has been found. On account of its resemblance to the typhoid bacillus there is a possible source of error here, and yet it is as easy to account for one as for the other. Obviously the path of infection must be traced from the alimentary canal.

*Pulmonary Lesions Due to Colon Bacillus.*—Chantemesse and Widal were probably the first to show that in certain cases

<sup>1</sup> Archives de Physiol., 1886.

<sup>2</sup> Macaigne, p. 133.

<sup>3</sup> Correspondenzblatt für Schweizer Aerzte, July, 1889.

of bronchopneumonia the colon bacillus appeared to play the principal rôle as a pathogenic agent. About the same time, in 1891,<sup>1</sup> Macé and Simon de Nancy published a paper upon the infectious diarrhœas of children. In the cases which they reported they had found almost pure cultures of the colon bacillus in the stools, and concluded it to be the causal agent. In the lungs of those dying of the disease they found multiple lesions of broncho-pneumonia. They referred to the experience of Sevestre, who in 1887 presented a memoir on a similar lesion, and who laid especial stress upon the pulmonary complications of these cases. In a later communication he agreed with the writers just named, that the pulmonary lesions were doubtless due to the colon bacilli.

Since then it has been generally agreed among several writers that the organism has been found in great numbers, and unaccompanied by others, in the œdematous congestions and inflamed portions of the lungs. Among these writers are Welch, Cornil, Menetrier, and others. The last named had frequent opportunity during the epidemic of 1892, and frequently saw gray hepatization with gangrene in spots, and repeatedly found in the exudate the colon bacillus. Of much more importance for us, however, is the paper of Fischer and Levy,<sup>2</sup> who reported two cases of strangulated hernia with pulmonary complications, and who found in the broncho-pulmonic foci this colon bacillus. They emphasize the metastatic nature of the pulmonary lesions, considering them to be of intestinal origin. Certain it is that pulmonary complications do carry off patients after abdominal and intestinal operations, and that these fatalities should be carefully studied bacteriologically in the light of the few statements above made.

*Empyema Due to the Colon Bacillus.*—In 1888, Widal had to do with a case of ossifying pleurisy with subpleural abscess in an old man, after urinary trouble, and found in the pus which he withdrew the bacillus which had been described by Albarran under the title of pyogenes. We now know that Albarran's

<sup>1</sup> Revue Generale de Clinique et de Therapeutique.

<sup>2</sup> Deutsches Zeitschrift, f. Chir., 1891.

bacillus is identical with the colon bacillus; moreover, quite recently the same writer has found the same organism in the pus of cases of empyema, and there seems to be no doubt but that this organism may produce pus formation here as elsewhere. The probability is that in such cases the path of infection is from the mouth (saliva) rather than from the intestinal canal. These statements and views have been confirmed by Gilbert and Girode as well as by Dumontpallier.

The normal existence of the colon bacillus in the mouth, its occasional migration into inflamed bronchi, and the subsequent localization of its activity in the lungs or in the pleura are not difficult to understand. It is more difficult to account for its presence within the cranium and the production of *meningitis*, or its migration to the serous membranes of certain joints and the production there of collections of pus. Both of these things, however, are possible, and cases confirming this view have been reported by French authors.

#### GENERAL CONCLUSIONS.

These are, first of all, that this organism, which is constantly present in the intestinal canal, is not always a harmless inhabitant, but becomes at times an active invader. It does not confine itself alone to the intestinal mucosa, where it may set up most active desquamative lesions, but may pass this barrier and penetrate into the general circulation and exercise pernicious activity in numerous other organs, with toxic effects upon the system at large.

Paraplegia and other paralyses are known to be sequelæ of colon infection of various abdominal viscera; kidneys, liver, etc.

Herniary cholera, so called, is due to intoxication from the toxic products produced from the organism in its virulent condition.

While still confined to the alimentary canal, under certain conditions, it may give rise to infarcts as well as ulcerations, their gravity depending largely upon the activity of absorptions of toxic products.

From the intestinal canal the colon bacillus may ascend

along the biliary passages, determining at one time chole-cystitis, angio-cholitis and local necrosis, or at another multiple abscess in the liver.

It is known to be one of the frequent factors in peritonitis of intestinal origin. It ranks among the most active agents in cases of urinary infection, *e.g.*, cystitis, pyelitis, pyelo-nephritis, etc. Without going minutely into the question of identity of various bacillary forms found in the urine, especially in cases of septic urinary affection, it would be enough for the present purpose to insist that in the kidneys, as well as in the bladder, the colon bacillus may exert active pathogenic and pyogenic properties, and may be the active agent in producing cystitis, suppurative pyelitis and their kindred disturbances, as well as pus elsewhere, general infection and intoxication. These organisms may be introduced from without, as upon a catheter, or may be transferred from their normal habitat by some traumatism or by natural channels. In animals, at least, these microbes are in some measure eliminated by the kidneys after being injected into the circulation. The endocardium, the meninges, the pleura, articular serous membranes, and the lungs, are at times not exempt from the manifestations of its activity.

When ordinary antiseptic precautions are observed, it is probably the most powerful enemy with which the laparotomist has to contend. This fact gives plausibility to the views of those who claim that the best preparation for abdominal section is free catharsis for a few days previous to the operation. The researches of the past two or three years with regard to this organism have certainly justified the views which I have held and taught for some years, that there is a form of post-operative septicæmia which is due in no direct way to the operator or the operation, but is in fact that which it has often been called, *i.e.*, enterosepsis, or intestinal toxæmia, a genuine auto-intoxication, active and actual lesions being due to migration from the intestinal canal of the colon bacillus. The necessary inference from this is that constant attention to the intestinal canal should be the watchword of the surgeon, both in his preparation of patients for operation and his care of them thereafter. For a widespread



recognition of these facts I have elsewhere and more than once contended, but feel that the profession at large are not yet fully alive to their importance.

If I may sum up the conclusions of Macaigne, with which he terminates his excellent monograph, they are briefly as follows:

The colon bacillus has been identified with the bacillus Neapolitanus of Emmerich, the bacillus foetidus of Passet, the bacillus pyogenes of urinary infection of Albarran and Clado, and the bacillus lactis aerogenes, and perhaps with other forms described by other authors.

Ordinarily inoffensive, it may from causes not yet ascertained acquire a greater or lesser degree of virulence, according to which it may determine one or more of the following lesions:

A. Infectious enteritis.

(a) Acute form.

1. The algid forms: cholera nostras, cholera infantum.
2. The pyretic form: post-puerperal pseudo-infection, etc.

(b) The chronic form.

1. The wasting enteritis of children and of adults.

B. Dysentery.

Then if the intestinal barrier is broken down we may have peritonitis and herniary cholera. *Probably most, if not all cases of appendicitis belong, also, under this head.*

The ascent of the colon bacillus along the biliary passages may provoke, according to its virulence, (1) simple biliary infection, (2) acute jaundice, (3) suppurative angio-cholitis.

In the alimentary canal it is capable of provoking—in the mouth, false membrane; in the stomach and intestines, infarcts; and lower down, perirectal abscesses. The bacillus penetrating the intestinal mucosa may infect parts or organs at a distance, for example, the endocardium, the thyroid body, the lungs, etc.

Finally, the bacillus may in some way, not yet fully understood, provoke meningitis, urinary infection, pulmonary and articular lesions.

## ILLUSTRATIVE CASES FROM THE PRACTICE OF THE AUTHOR.

CASE I—*Cancer of the Intestine with Abscess*.—H. C. G., aged twenty-two, was taken sick, apparently with dysentery, during which he rapidly emaciated and developed a tender, painful tumor to the left of and below the umbilicus. This tumor was watched some time, and finally showed evidences of the presence of pus. It was opened, under ether, and some 75 c.c. of foul-smelling pus evacuated from apparently a sub-peritoneal cavity, around which there was considerable induration. This cavity closed, then reopened, the tumor grew in size, and subsequently proved to be of malignant character, involving several loops of intestine in one firm, dense mass. The case was under the care of Dr. D. W. Harrington, and the operation was made by myself. In the pus from the above abscess no organism could be found save the colon bacillus.

CASE II—*Recurring Peri-appendical Abscess*.—H. T., aged forty-eight. This patient was operated on April 8, 1892, for acute peri-appendical abscess. In November, 1892, he returned with another large abscess pointing externally in the old scar. The appendix had not been removed during the first operation, for the reason that it could not be found without what seemed to be injudicious disturbance of the parts. November 26 the patient was operated on the second time, and nearly a pint of material evacuated. The pus from this case gave a pure culture of the colon bacillus, which, however, showed no special virulence.

CASE III—*Acute Abscess of the Liver*.—J. C., aged thirty-three. Four weeks previous to entering the hospital he was seized with sharp pain in the right side which caused him to give up work. Since then he has been very sick, and was brought to the hospital four days before the operation with a temperature often as high as 106°, with frequent chills, great soreness, and some swelling in the region of the liver. Referred to me by Dr. Chas. Cary, December 28, 1892. I anæsthetized him and evacuated a very large abscess in the liver by incision between the tenth and eleventh ribs, just back of the axillary line. At the time of the operation about twenty-five ounces of thick, ropy pus slowly escaped. The temperature at once subsided, to remain low, and he made a rapid recovery. In his case the pus was a pure culture of the bacterium coli commune.

CASE IV—*Gangrenous Appendicitis*.—H. W., aged sixteen, was sent to the hospital by Dr. S. G. Dorr. This was a case of gangren-

ous appendicitis of eight days' duration. Although the appendix was found gangrenous at the time of the operation, the patient had never seemed very sick. Two days before the operation he was able to walk, and when I first saw him, the day previous, he moved in bed without pain, and was not extremely tender, although the tumor was as big as my fist. From this, on the following day, several ounces of fetid pus were evacuated, and the appendix, almost completely gangrenous, was easily removed. He only stayed eight days in the hospital, and then went home nearly recovered. Pus from this case showed nothing but colon bacilli.

CASE V—*Acute Appendicitis with Perforation and Obstruction of the Bowels.*—H. J., aged forty-eight, gives a history of three attacks within the recent past of pain and soreness in the right iliac fossa. January 13, 1893, he was taken with very severe pain, and became a patient of Drs. Greene, with whom I saw him four days later, when he had fecal vomiting and all the signs of intestinal obstruction, but without any localized tenderness. The same day I operated, and after opening in the middle line, on exploring toward the right iliac fossa some slight adhesions gave way, and there came a gush of several ounces of fresh thin pus, having a strong fecal odor. As well as I could, under the circumstances, and by gas light, I examined the region of the cæcum, but could find there no definite lesion. The patient died about fifty hours later, and on autopsy there was found a gangrenous appendix with circumscribed gangrene of the adjoining portion of the cæcum. Examination of the pus removed at the time of the operation showed colon bacilli, and nothing else.

CASE VI—*Cholecystitis Suppurativa.*—During the same week I was called out of town to see an elderly woman in whose case both the history and the local symptoms pointed to an acute appendicitis, in fact, every sign of it was present save perceptible tumor. She had had chills and high temperature, and the tumor had been distinctly perceptible in that region within a day or two. Her chills were followed by an alarming collapse. An operation was deemed necessary at once. When I saw her in the evening her temperature was down, and she had involuntary stools, and there was tenderness across the lower bowels. Under ether I made a long oblique incision over the appendix, and upon working my way down to it found it perfectly free and apparently normal. Exploring upward I came upon a large distended gall bladder, and aspiration with a fine needle showed it

to be full of apparently sero-pus. I closed the lower incision, made a second one over the gall bladder, sewed it to the peritoneum with four fine silk sutures, and left it to be opened the following day. The contents of the gall-bladder, as withdrawn by the aspirating needle, showed a sero-purulent liquid which contained colon bacilli and streptococci. The patient made a final though slow recovery, over forty gall stones being later removed by Dr. Richmond, of Fredonia, N. Y.